

CLAIMS

I/We claim:

- [c1] 1. A method for treating movement disorders, comprising:
providing an image showing a relative position between an external marker
on a patient and at least one of the central sulcus, the precentral
gyrus and/or the postcentral gyrus of the patient;
identifying a stimulation site proximate to the dura of the patient and over
the precentral gyrus relative to the external marker; and
applying neural stimulation directly to the stimulation site.
- [c2] 2. The method of claim 1, further comprising implanting an electrode at
the stimulation site, and wherein applying neural stimulation comprises passing
an electrical current through the electrode.
- [c3] 3. The method of claim 2 wherein implanting the electrode comprises
positioning an array having a plurality of electrodes over only the precentral gyrus
of the patient.
- [c4] 4. The method of claim 2 wherein implanting the electrode comprises
positioning an array having a plurality of electrodes such that at least one
electrode is over the precentral gyrus and at least one other electrode is over the
postcentral gyrus of the patient.
- [c5] 5. The method of claim 1, further comprising implanting an electrode
array having a plurality of first electrodes arranged in a first row and a plurality of
second electrodes arranged in a second row at the stimulation site, and wherein
applying neural stimulation comprises passing an electrical current through at
least one of the electrodes.

- [c6] 6. The method of claim 5 wherein implanting the electrode array comprises positioning the first and second rows at an oblique angle relative to the central sulcus.
- [c7] 7. The method of claim 5 wherein implanting the electrode array comprises positioning one of the first electrodes and one of the second electrodes over the precentral gyrus of the patient, and positioning another one of the first electrodes and another one of the second electrodes over the postcentral gyrus of the patient.
- [c8] 8. The method of claim 1 wherein applying neural stimulation directly to the stimulation site comprises delivering an electrical current directly to the dura of the patient at the stimulation site.
- [c9] 9. The method of claim 1 wherein applying neural stimulation directly to the stimulation site comprises delivering an electrical current directly to the patient at least proximate to the dura over the stimulation site.
- [c10] 10. The method of claim 9 wherein delivering an electrical current directly to the patient comprises applying a unipolar electrical potential to an electrode implanted at the stimulation site.
- [c11] 11. The method of claim 9 wherein delivering an electrical current directly to the patient comprises applying a unipolar electrical potential to a plurality of electrodes implanted at the stimulation site.
- [c12] 12. The method of claim 9 wherein delivering an electrical current directly to the patient comprises applying a bipolar electrical potential to a plurality of electrodes implanted at the stimulation site.

- [c13] 13. The method of claim 1 wherein the patient has a movement disorder that is worse on a first side of the patient than on a second side of the patient opposite the first side, and wherein the method further comprises implanting an electrode over the precentral gyrus on the second side of the patient only.
- [c14] 14. A method for treating movement disorders, comprising:
locating a stimulation site at least proximate to the dura and along the precentral gyrus of a patient by imaging at least one of the precentral gyrus, central sulcus and/or postcentral gyrus of the patient relative to an external marker on the patient; and
applying neural stimulation directly to the stimulation site.
- [c15] 15. The method of claim 14, further comprising implanting an electrode at the stimulation site, and wherein applying neural stimulation comprises passing an electrical current through the electrode.
- [c16] 16. The method of claim 15 wherein implanting the electrode comprises positioning an array having a plurality of electrodes over only the precentral gyrus of the patient.
- [c17] 17. The method of claim 15 wherein implanting the electrode comprises positioning an array having a plurality of electrodes such that at least one electrode is over the precentral gyrus and at least one other electrode is over the postcentral gyrus of the patient.
- [c18] 18. The method of claim 14, further comprising implanting an electrode array having a plurality of first electrodes arranged in a first row and a plurality of second electrodes arranged in a second row at the stimulation site, and wherein applying neural stimulation comprises passing an electrical current through at least one of the electrodes.

- [c19] 19. The method of claim 18 wherein implanting the electrode array comprises positioning the first and second rows at an oblique angle relative to the central sulcus.
- [c20] 20. The method of claim 18 wherein implanting the electrode array comprises positioning one of the first electrodes and one of the second electrodes over the precentral gyrus of the patient, and positioning another one of the first electrodes and another one of the second electrodes over the postcentral gyrus of the patient.
- [c21] 21. The method of claim 14 wherein applying neural stimulation directly to the stimulation site comprises delivering an electrical current directly to the dura of the patient at the stimulation site.
- [c22] 22. The method of claim 14 wherein applying neural stimulation directly to the stimulation site comprises delivering an electrical current directly to the patient at least proximate to the dura over the stimulation site.
- [c23] 23. The method of claim 22 wherein delivering an electrical current directly to the patient comprises applying a unipolar electrical potential to an electrode implanted at the stimulation site.
- [c24] 24. The method of claim 22 wherein delivering an electrical current directly to the patient comprises applying a unipolar electrical potential to a plurality of electrodes implanted at the stimulation site.
- [c25] 25. The method of claim 22 wherein delivering an electrical current directly to the patient comprises applying a bipolar electrical potential to a plurality of electrodes implanted at the stimulation site.

[c26] 26. The method of claim 14 wherein the patient has a movement disorder that is worse on a first side of the patient than on a second side of the patient opposite the first side, and wherein the method further comprises implanting an electrode over the precentral gyrus on the second side of the patient only.

[c27] 27. A method for treating movement disorders, comprising:
implanting an electrode array having a plurality of first electrodes arranged in a first row and a plurality of second electrodes arranged in a second row at a stimulation site over the central sulcus of the patient; and
applying an electrical signal to at least some of the first electrodes and/or the second electrodes.

[c28] 28. The method of claim 27 wherein implanting the electrode array comprises positioning the first and second rows at an oblique angle relative to the central sulcus.

[c29] 29. The method of claim 27 wherein implanting the electrode array comprises positioning one of the first electrodes and one of the second electrodes over the precentral gyrus of the patient, and positioning another one of the first electrodes and another one of the second electrodes over the postcentral gyrus of the patient.

[c30] 30. The method of claim 27 wherein applying an electrical signal comprises delivering an electrical current directly to the dura of the patient at the stimulation site.

[c31] 31. The method of claim 27 wherein applying an electrical signal comprises delivering an electrical current directly to the patient at least proximate to the dura over the stimulation site.

[c32] 32. The method of claim 31 wherein delivering an electrical current directly to the patient comprises applying a unipolar electrical potential to a single electrode implanted at the stimulation site.

[c33] 33. The method of claim 31 wherein delivering an electrical current directly to the patient comprises applying a unipolar electrical potential to a plurality of the electrodes implanted at the stimulation site.

[c34] 34. The method of claim 31 wherein delivering an electrical current directly to the patient comprises applying a bipolar electrical potential to a plurality of the electrodes implanted at the stimulation site.

[c35] 35. The method of claim 27 wherein the patient has a movement disorder that is worse on a first side of the patient than on a second side of the patient opposite the first side, and wherein implanting the electrode array comprises positioning the electrode array over the precentral gyrus on the second side of the patient only.

[c36] 36. A method for treating a patient having a movement disorder that is worse on a first side of the patient than on a second side of the patient opposite the first side; comprising:

implanting an electrode at a stimulation site located over at least a portion of the precentral gyrus of the patient on only the second side of the patient; and

applying stimulation to the electrode to treat the movement disorder on both the first side and the second side of the patient.

[c37] 37. The method of claim 36 wherein implanting the electrode comprises positioning an array having a plurality of electrodes over only the precentral gyrus of the patient.

[c38] 38. The method of claim 36 wherein implanting the electrode comprises positioning an array having a plurality of electrodes such that at least one electrode is over the precentral gyrus and at least one other electrode is over the postcentral gyrus of the patient on only the second side of the patient.

[c39] 39. The method of claim 36, wherein implanting the electrode comprising placing an array having a plurality of first electrodes arranged in a first row and a plurality of second electrodes arranged in a second row at the stimulation site.

[c40] 40. The method of claim 39 wherein implanting the electrode array comprises positioning the first and second rows at an oblique angle relative to the central sulcus of the patient.

[c41] 41. The method of claim 39 wherein implanting the electrode array comprises positioning one of the first electrodes and one of the second electrodes over the precentral gyrus of the patient, and positioning another one of the first electrodes and another one of the second electrodes over the postcentral gyrus of the patient.

[c42] 42. The method of claim 36 wherein applying stimulation to the electrode comprises delivering an electrical current directly to the dura of the patient at the stimulation site.

- [c43] 43. The method of claim 36 wherein applying stimulation to the electrode comprises delivering an electrical current directly to the patient at least proximate to the dura over the stimulation site.
- [c44] 44. The method of claim 43 wherein delivering an electrical current directly to the patient comprises applying a unipolar electrical potential to the electrode implanted at the stimulation site.
- [c45] 45. The method of claim 43 wherein delivering an electrical current directly to the patient comprises applying a unipolar electrical potential to a plurality of electrodes implanted at the stimulation site.
- [c46] 46. The method of claim 43 wherein delivering an electrical current directly to the patient comprises applying a bipolar electrical potential to a plurality of electrodes implanted at the stimulation site.
- [c47] 47. A method for treating movement disorders, comprising:
determining a site at the cortex of the brain of a patient related to a movement disorder of an afflicted body part by obtaining a representation of neural activity occurring in the cortex of the patient and correlating an area of neural activity with the afflicted body part;
and
applying neural stimulation directly to the site.
- [c48] 48. The method of claim 47, further comprising implanting an electrode proximate to the dura mater at the site, and wherein applying neural stimulation to the site comprises electrically biasing the electrode.
- [c49] 49. The method of claim 47 wherein obtaining a representation of neural activity occurring in the cortex comprises imaging neural activity in the cortex

using a neural imaging technique while the patient mentally concentrates on moving the afflicted body part.

[c50] 50. The method of claim 47 wherein obtaining a representation of neural activity occurring in the cortex comprises imaging neural activity in the cortex using a neural imaging technique while the patient moves the afflicted body part.

[c51] 51. The method of claim 47 wherein obtaining a representation of neural activity occurring in the cortex comprises imaging neural activity in the cortex using a neural imaging technique while applying an electrical pulse to the afflicted body part.

[c52] 52. The method of claim 47 wherein obtaining a representation of neural activity occurring in the cortex comprises imaging neural activity in the cortex using a neural imaging technique while an entity other than the patient passively moves the afflicted body part.

[c53] 53. The method of claim 47 further comprising implanting an electrode proximate to the dura mater at the site, and wherein applying neural stimulation to the site comprises applying an electrical waveform having a frequency of approximately 50-500 Hz.

[c54] 54. The method of claim 47 further comprising implanting an electrode proximate to the dura mater at the site, and wherein applying neural stimulation to the site comprises applying an electrical waveform having a frequency of approximately 90-130 Hz.

[c55] 55. The method of claim 47 further comprising implanting an electrode proximate to the dura mater at the site, and wherein applying neural stimulation to

the site comprises applying an electrical waveform having a frequency of approximately 100 Hz.

[c56] 56. The method of claim 47 further comprising implanting an electrode proximate to the dura mater at the site, and wherein applying neural stimulation to the site comprises applying an electrical waveform having a frequency of approximately 120 Hz.

[c57] 57. A method of treating movement disorders, comprising:
providing a representation of neural activity in the cortex of the brain of a patient;
identifying an area of neural activation on the representation expected to be related to a body part of the patient affected by a movement disorder;
selecting a stimulation site on the patient by referencing the identified area of neural activation to the anatomy of the brain of the patient; and
applying electrical stimulation to the cortex of the patient at the stimulation site.

[c58] 58. The method of claim 57 wherein providing a representation of neural activity and identifying an area of neural activity related to the affected body part comprises imaging neural activity in the cortex using a neural imaging technique while the patient mentally concentrates on moving the affected body part and noting an area on the image reacting to the mental concentration of the patient.

[c59] 59. The method of claim 57 wherein providing a representation of neural activity and identifying an area of neural activity related to the affected body part comprises imaging neural activity in the cortex using a neural imaging technique while the patient moves the affected body part and noting an area on the image reacting to the movement of the affected body part.

[c60] 60. The method of claim 57 wherein providing a representation of neural activity and identifying an area of neural activity related to the affected body part comprises imaging neural activity in the cortex using a neural imaging technique while applying an electrical pulse to the affected body part and noting an area on the image reacting to the electrical pulse applied to the affected body part.

[c61] 61. The method of claim 57 wherein providing a representation of neural activity and identifying an area of neural activity related to the affected body part comprises imaging neural activity in the cortex using a neural imaging technique while an entity other than the patient passively moves the affected body part and noting an area on the image reacting to movement of the affected body part.

[c62] 62. A method of treating movement disorders, comprising:
performing a craniotomy to expose a cortical location for neural activity related to a body part affected by a movement disorder;
applying a test electrical stimulation waveform to a plurality of discrete regions of the cortical location;
mapping the test electrical stimulation waveform applied to the discrete regions to the efficacy in treating the movement disorder of the affected body part;
selecting one or more of the discrete regions that have a desired efficacy for treating the movement disorder; and
applying a therapy electrical stimulation waveform to the one or more selected discrete regions of the cortical location.

[c63] 63. The method of claim 62, further comprising identifying the cortical location for the neural activity related to the affected body part before performing the craniotomy by providing a representation of neural activity in the cortex, ascertaining an area of neural activation on the representation related to the body

part affected by the movement disorder, and referencing the ascertained area of neural activation to the external anatomy of the patient.

[c64] 64. The method of claim 62, further comprising identifying the cortical location for the neural activity related to the affected body part before performing the craniotomy by estimating where neural activity related to the movement disorder of the affected body part is expected to occur in accordance with a standard correlation between cortical neural activity and motor functions in humans.

[c65] 65. A method of treating a movement disorder that affects a body part of a patient, comprising:

implanting an electrode at a cortical stimulation site other than the precentral gyrus where neural activity related the movement disorder of the affected body part is expected to occur; and
applying electrical stimulation to the cortical stimulation site by electrically biasing the electrode.

[c66] 66. A method of selecting a stimulation site for a patient having a movement disorder, comprising:

providing an image showing a relative position between an external marker on a patient and at least one of the central sulcus, the precentral gyrus and/or the postcentral gyrus of the patient; and
identifying a stimulation site proximate to the dura of the patient and over the precentral gyrus relative to the external marker.

[c67] 67. A method of selecting a stimulation site for a patient having a movement disorder, comprising:

obtaining an image of at least one of the precentral gyrus, central sulcus and/or postcentral gyrus of the patient relative to an external marker on the patient;

locating a stimulation site on the image relative to the external marker that is over at least one of the precentral gyrus, central sulcus and/or postcentral gyrus of the patient and proximate to the dura according to the image; and

correlating the stimulation site on the image with an external site on the patient.

[c68] 68. A method of selecting a stimulation site for a patient having a movement disorder that is worse on a first side of the patient than on a second side of the patient opposite the first side; comprising:

ascertaining a homologous region of the cortex of the patient associated with control of the movement disorder; and

identifying a stimulation site relative to the homologous region on only the second side of the patient.

[c69] 69. The method of claim 68 wherein the stimulation site is the homologous region associated with the movement disorder on the second side of the patient.

[c70] 70. The method of claim 68 wherein the stimulation site is a non-homologous region relative to the movement disorder on the second side of the patient.

[c71] 71. A method of selecting a stimulation site for a patient having a movement disorder, comprising:

obtaining a representation of neural activity occurring in the cortex of a patient and correlating an area of neural activity with a body part afflicted by the movement disorder; and
correlating the representation of the area of neural activity in the cortex of the patient with an external site on the patient.